(2)

INTERIM REPORT

OCTOBER 1988

# REPORT NO. EVT 10-89

# ENGINEERING TEST OF 105mm HOWITZER CARTRIDGES IN HORIZONTAL CONFIGURATION



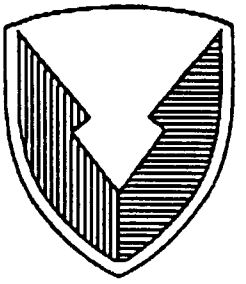


Prepared for:

U.S. Army Armament Research, Development and Engineering Center
ATTN: SMCAR-AEP
Picatinny Arsenal, NJ 07806-5000







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EVALUATION DIVISION
SAVANNA, ILLINOIS 61074-9639

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

The U.S. Army Defense Ammunition Center and School (USADACS), Evaluation Division (SMCAC-DEV), has been tasked by the U.S. Army Armament, Research, Development and Engineering Center (ARDEC), SMCAR-AEP, Picatinny Arsenal, NJ, to develop and test a pallet assembly for the metal 105mm Howitzer Cartridge Container in a horizontal configuration of one long by nine wide by six high. The methods and results of MIL-STD-1660 testing on the pallet manufactured for the above configuration are contained within this report. The outcome of these tests indicates that several design changes need to be made to the pallet before it will be acceptable.

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U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL
Evaluation Division
Savanna, IL 61074-9639

# REPORT NO. DEV 13-87
# ENGINEERING TEST OF 105mm HOWITZER CARTRIDGE IN HORIZONTAL CONFIGURATION

## TABLE OF CONTENTS

# PART 1

## INTRODUCTION

A. BACKGROUND. The U.S. Army Defense Ammunition Center and School (USADACS), Evaluation Division, was tasked by the U.S. Army Armament Research, Development and Engineering Center (ARDEC), SMCAR-AEP, to develop and test a pallet assembly for 105mm Howitzer Cartridge Containers in a horizontal configuration of one long by nine wide by six high. The testing procedures that were used for evaluating the pallet consisted of MIL-STD-1660, Design Criteria for Ammunition Unit Loads.

B. AUTHORITY. This test was conducted in accordance with mission responsibilities delegated by the U.S. Army Armament, Munitions and Chemical Command (AMCCOM), Rock Island, Illinois.

C. OBJECTIVE. The objective of these tests was to determine if the preliminary designed pallet configuration needed any modification prior to construction of additional pallets. Due to a lack of containers, the MIL-STD-1660 tests were conducted using a configuration of one long by nine wide by four high.

# PART 2

## ATTENDEES


Quinn Hartman
Test Engineer

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AV 585-8992

# PART 3

## TEST PROCEDURES

The test procedures outlined in this section were extracted from MIL-STD-1660, Design Criteria for Ammunition Unit Loads, 8 April 1977. This standard identifies nine steps that a unitized load must undergo if it is considered to be acceptable. The five tests that were conducted on the test pallet are synopsized below.

1. STACKING TESTS. The unit load shall be loaded to simulate a stack of identical unit loads stacked 16 feet high, for a period of one hour. This stacking load is simulated by subjecting the unit load to a compression weight equal to an equivalent 16-foot stacking height. The compression load is calculated in the following manner: The unit load weight is divided by the unit load height in inches and multiplied by 192. The resulting number is the equivalent compressive load of a 16-foot-high stack.

2. REPETITIVE SHOCK TEST. The repetitive shock test shall be conducted in accordance with Method 5019, Federal Standard 101. The test procedure is as follows: The test specimen shall be placed on, but not fastened to, the platform. With the specimen in one position, vibrate the platform at 1/2-inch amplitude (1-inch double amplitude) starting at a frequency of about 3-cycles-per-second. Steadily increase the frequency until the package leaves the platform. The resonant frequency is achieved when a 1/16-inch-thick feeler may be momentarily slid freely between every point on the specimen in contact with the platform at some instance during the cycle or a

platform acceleration achieves one plus or minus zero point one G. Midway into the testing period the specimen shall be rotated 90 degrees and the test continued for the duration. Unless failure occurs, the total time of vibration shall be two hours if the specimen is tested in one position; and, if tested in more than one position, the total time shall be three hours.

3. EDGEWISE DROP TEST. This test shall be conducted by using the procedures of Method 5008, Federal Standard 101. The procedure for the Edgewise Drop (Rotational) Test is as follows: The specimen shall be placed on its bottom with one end of the base of the container supported on a sill nominally 6 inches high. The height of the sill shall be increased, if necessary, to ensure that there will be no support for the base between the ends of the container when dropping takes place, but should not be high enough to cause the container to slide on the supports when the dropped end is raised for the drops. The unsupported end of the container shall then be raised and allowed to fall freely to the concrete, pavement, or similar underlying surface from a prescribed height. Unless otherwise specified, the height of drop for level A protection shall conform to the following tabulation.

Table 1: Drop Levels

| GROSS WEIGHT NOT EXCEEDING | DIMENSIONS ON ANY EDGE NOT EXCEEDING | HEIGHT OF DROP LEVEL A PROTECTION |
|---|---|---|
| 600 lbs. | 72 inches | 36 inches |
| 3,000 lbs. | no limit | 24 inches |
| no limit | no limit | 12 inches |

4. SLING COMPATIBILITY TEST. Unit loads utilizing special design for nonstandard pallets shall be lifted, slung, lowered, and otherwise handled as necessary using slings of the types normally used for handling the unit loads under consideration. Slings shall be easily attached and removed. Danger of slippage or disengagement when load is suspended shall be cause for rejection of the unit load.

5. IMPACT TEST. This test shall be conducted by using the procedure of Method 5023, Incline-Impact Test of Federal Standard 101. The procedure for the Incline-Impact Test is as follows: The specimen shall be placed on the carriage with the surface or edge which is to be impacted projecting at least 2 inches beyond the front end of the carriage. The carriage shall be brought to a predetermined position on the incline and released. If it is desired to concentrate the impact on any particular position on the container, a 4x4-inch timber may be attached to the bumper in the desired position before the test. No part of the timber shall be struck by the carriage. The position of the container on the carriage and the sequence in which surfaces and edges are subjected to impacts may be at the option of the testing activity and will depend upon the objective of the tests. When the test is to determine satisfactory requirements for a container or pack, and, unless otherwise specified, the specimen shall be subjected to one impact on each surface that has each dimension less than 9.5 feet. Unless otherwise specified, the velocity at time of impact shall be 7 feet per second.

# PART 4

## TEST EQUIPMENT

1. TEST SPECIMEN.

| | |
|---|---|
| a. Drawing Number: | AC200000490 |
| b. Width: | 43 inches |
| c. Length: | 55 inches |
| d. Height: | 30-3/4 inches (Bell End), 29-3/8 inches (NonBell End) |
| e. Weight: | 2,350 pounds |

2. COMPRESSION TESTER.

| | |
|---|---|
| a. Manufacturer: | Ormond Manufacturing |
| b. Platform: | 60 inches by 60 inches |
| c. Compression Limit: | 50,000 pounds |
| d. Tension Limit: | 50,000 pounds |

3. TRANSPORTATION SIMULATOR.

| | |
|---|---|
| a. Manufacturer: | Gaynes Laboratory |
| b. Capacity: | 6,000-pound pallet |
| c. Displacement: | 1/2-inch Amplitude |
| d. Speed: | 50 to 400 rpm |
| e. Platform: | 5 feet by 8 feet |

4. INCLINED RAMP.

| | |
|---|---|
| a. Manufacturer: | Conbur Incline |
| b. Type: | Impact Tester |
| c. Grade: | 10 percent Incline |
| d. Length: | 12-foot Incline |

# PART 5

## TEST RESULTS

1. STACKING TEST. During the first phase of testing, the pallet assembly was noted to be fabricated incorrectly. However, since the production pallet and assemblies would vary significantly, the pallet was tested as is to obtain engineering data. In order to conduct the stacking test, wood shims had to placed on top of the pallet to evenly distribute the load from the compression tester because the pallet base was improperly assembled. The test pallet was loaded to 14,800 pounds compression for a period of one hour. At the end of the one hour period, the compression load had not decreased and the load had not compressed. No damage was noted to the pallet or contents.

2. REPETITIVE SHOCK TEST. The test pallet successfully passed both the longitudinal and lateral transportation simulation. Duration of the test was 90 minutes for each orientation of the pallet. In order to achieve the required 1/16-inch clearance between the pallet and the Transportation Simulator bed, the equipment was operated at 225 rpm for the longitudinal orientation and 215 rpm for the lateral orientation. Damage to the pallet consisted of several cracks in the posts of the pallet near the welds that attach the skid to the post.

3. EDGEWISE DROP TEST. Each side of the pallet base was placed on a beam displacing it 6 inches above the floor. The opposite side was raised to a height of 24 inches above the floor and then dropped. This process was repeated in a clockwise

direction until all four sides of the pallet had been tested. During drops 2 and 4, the pallet base was bent allowing the pallet to rock. Also, additional cracks in the posts were discovered following the drop tests.

4. SLING TEST. The sling test consisted of five different lifting configurations using a top lift adapter and a four-legged sling. The configurations used for this test consisted of a four corner, three corner, two alternate corners, two adjacent corners, and a single corner lift. No damage was sustained by the pallet or the top lift adapter from the sling test.

5. IMPACT TEST. The incline impact tester was set to allow the pallet to travel 8 feet before impacting the bumper of the impact tester. In between impacts, the pallet was rotated in a clockwise direction until all four sides of the pallet had been impacted. The only damage sustained during the impact test was additional bending in the toplift frame and pallet base that increased the degree that the pallet could rock.

# PART 6

## CONCLUSIONS AND RECOMMENDATIONS

1. CONCLUSIONS. The test pallet marginally passed all phases of the MIL-STD-1660 criteria for ammunition unit loads. The only damage sustained by the test pallet during the series of tests was small cracks in the posts and bending of the pallet base and top lift frame. The unit load as tested is unacceptable, however, for the following reasons.

a. The pallet top lift was not parallel with the pallet base due to improper manufacture of the pallet base. This defect would make stacking of the pallet unsafe and impractical.

b. The restraining strap at the bell end of the pallet was not parallel with the other two straps.

c. The top lift frame does not extend far enough towards the non-bell (base) end of the pallet to support the skid of the upper pallet when stacked.

2. RECOMMENDATIONS. Since there were major problems with the pallet at the time it was tested, it is recommended that the above problems be corrected and additional testing be conducted utilizing a smaller standard pallet to provide a more efficient (taller) unit load. The change to the smaller standard pallet is due to a change in the maximum weight of the pallet from 4000 pounds to 2500 pounds. Also, in addition to the problems mentioned above, a design change should be made to the posts on the pallet to eliminate the cracking that occurred during testing. The

MIL-STD-1660 testing was conducted only as a means to collect engineering data and was not meant as a means to approve or disapprove the unit load design.

# PART 7

## PHOTOGRAPHS

**DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL**

Photo 1: This photo shows the pallet in the Compression Tester.

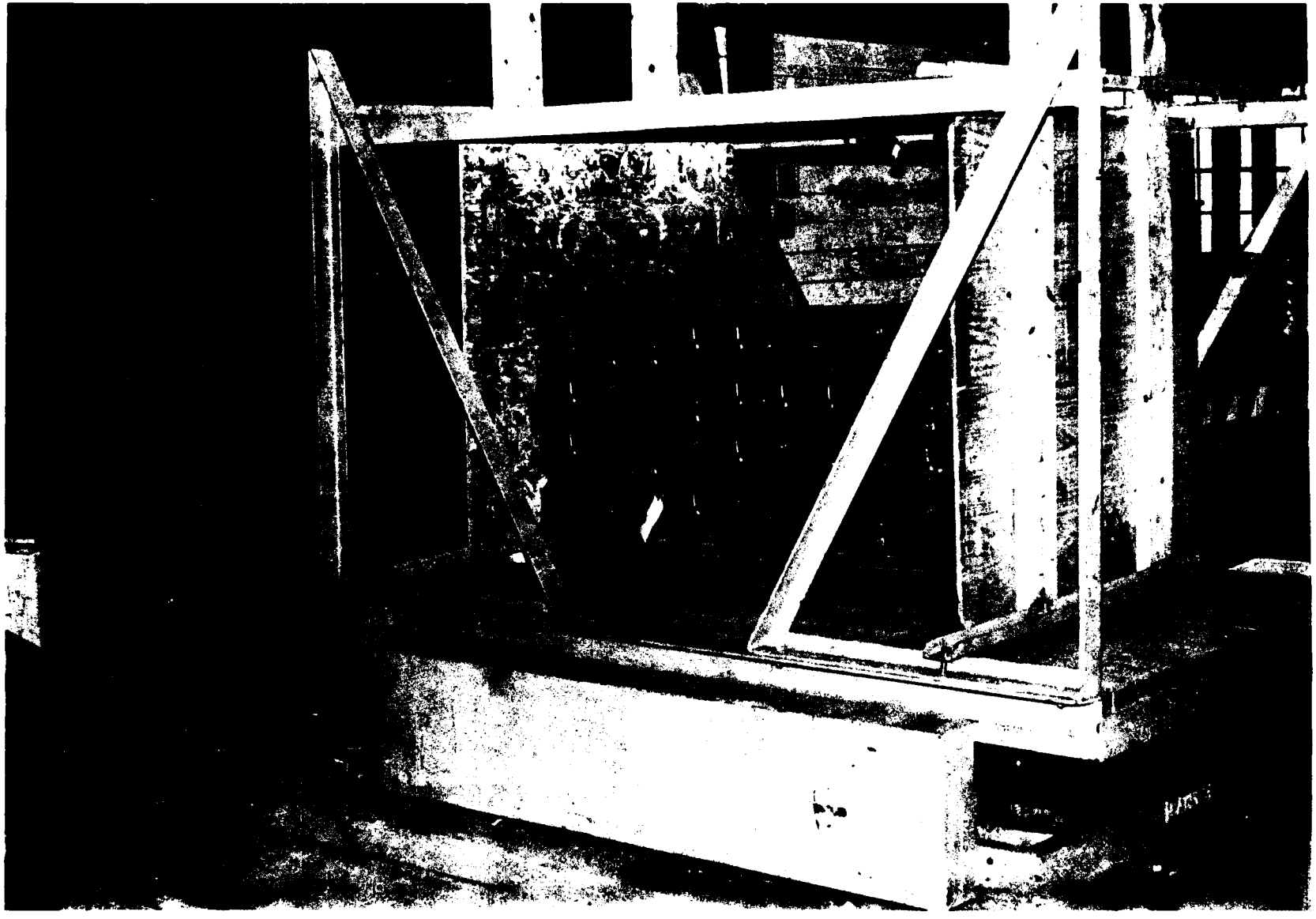

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Photo 2: This photo shows the pallet in the Transportation Simulator in the Longitudinal Orientation

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Photo 3: This photo show the pallet in the Transportation Simulator in the Lateral Orientation

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Photo 4: This photo shows the pallet raised 24 inches prior to the first edgewise drop

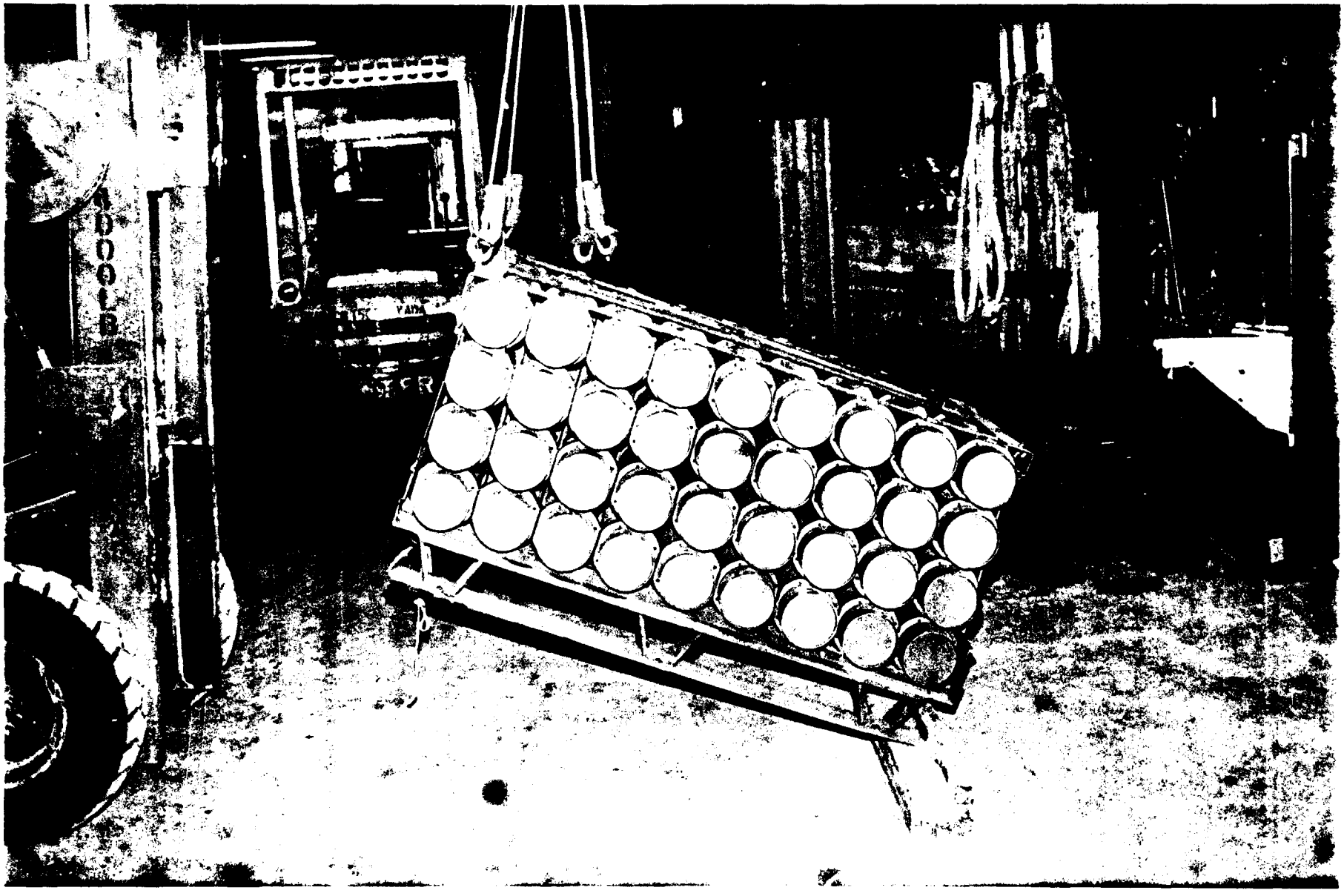

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Photo 5: This photo show the pallet raised 24 inches prior to the second edgewise drop.

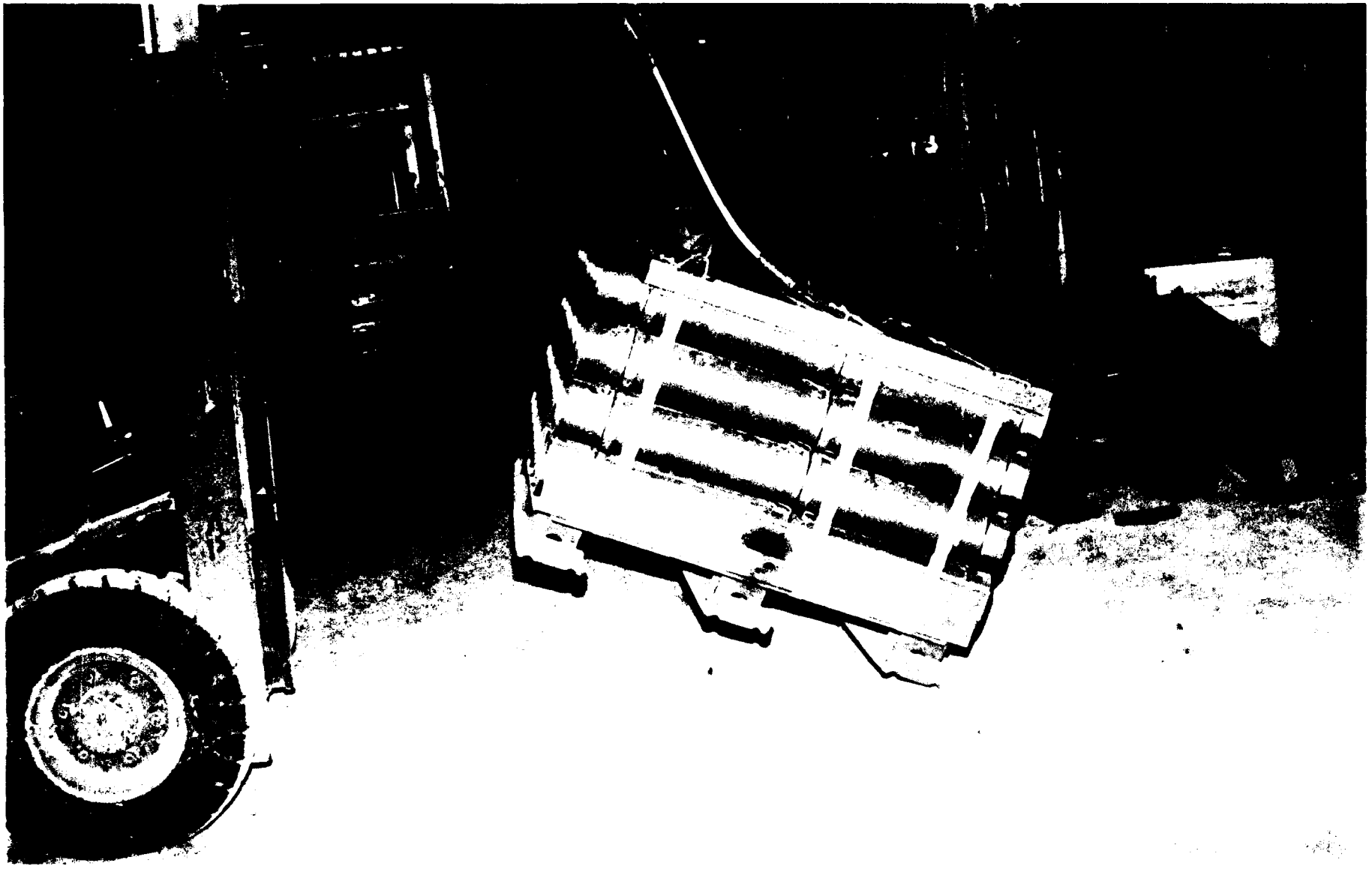

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Photo 6: This photo show the pallet raised 24 inches prior to the third edgewise drop.

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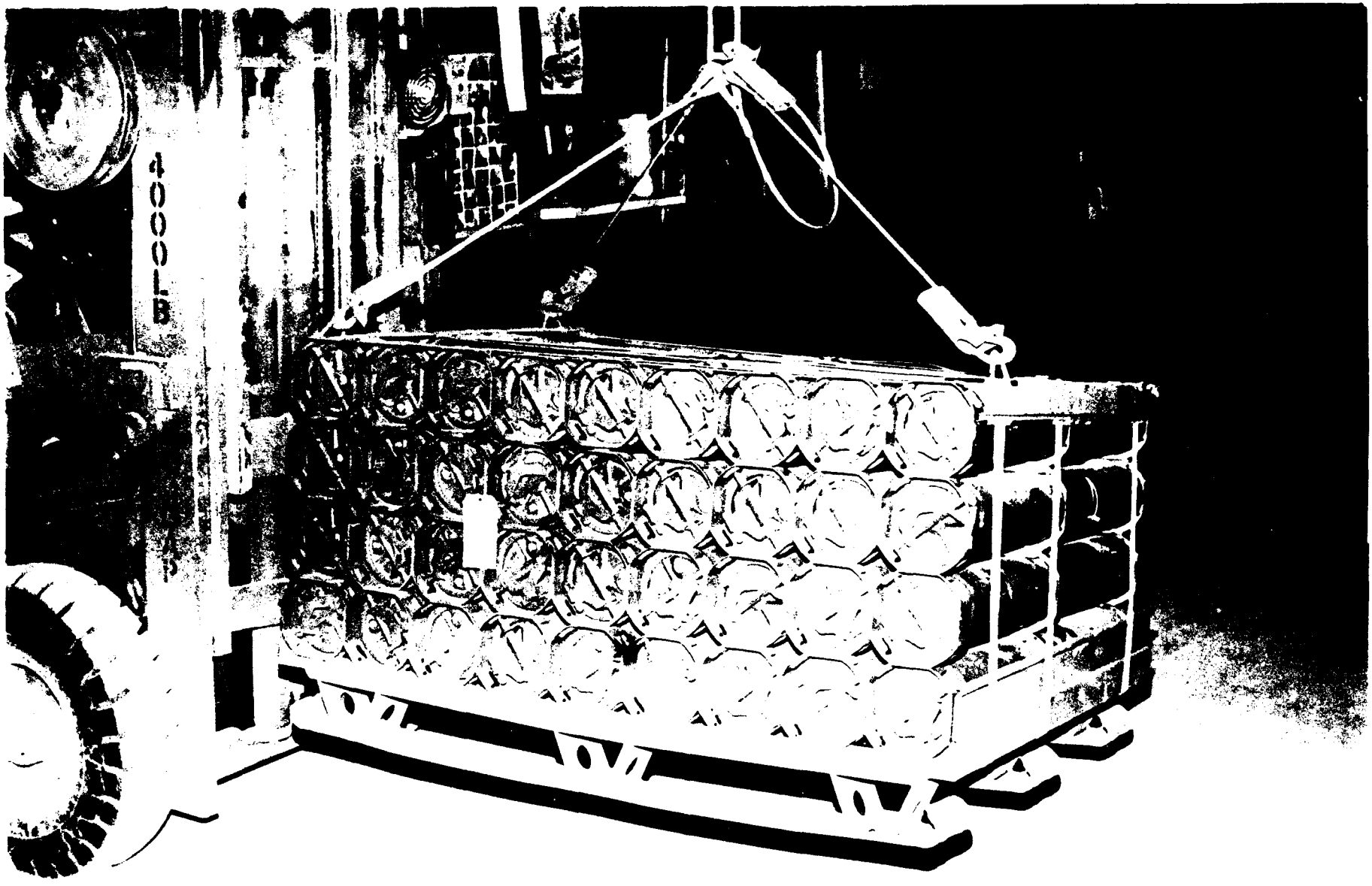
Photo 7: This photo show the pallet raised 24 inches prior to the fourth edgewise drop.

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| Photo 8: This photo shows the pallet being top lifted by four points. |

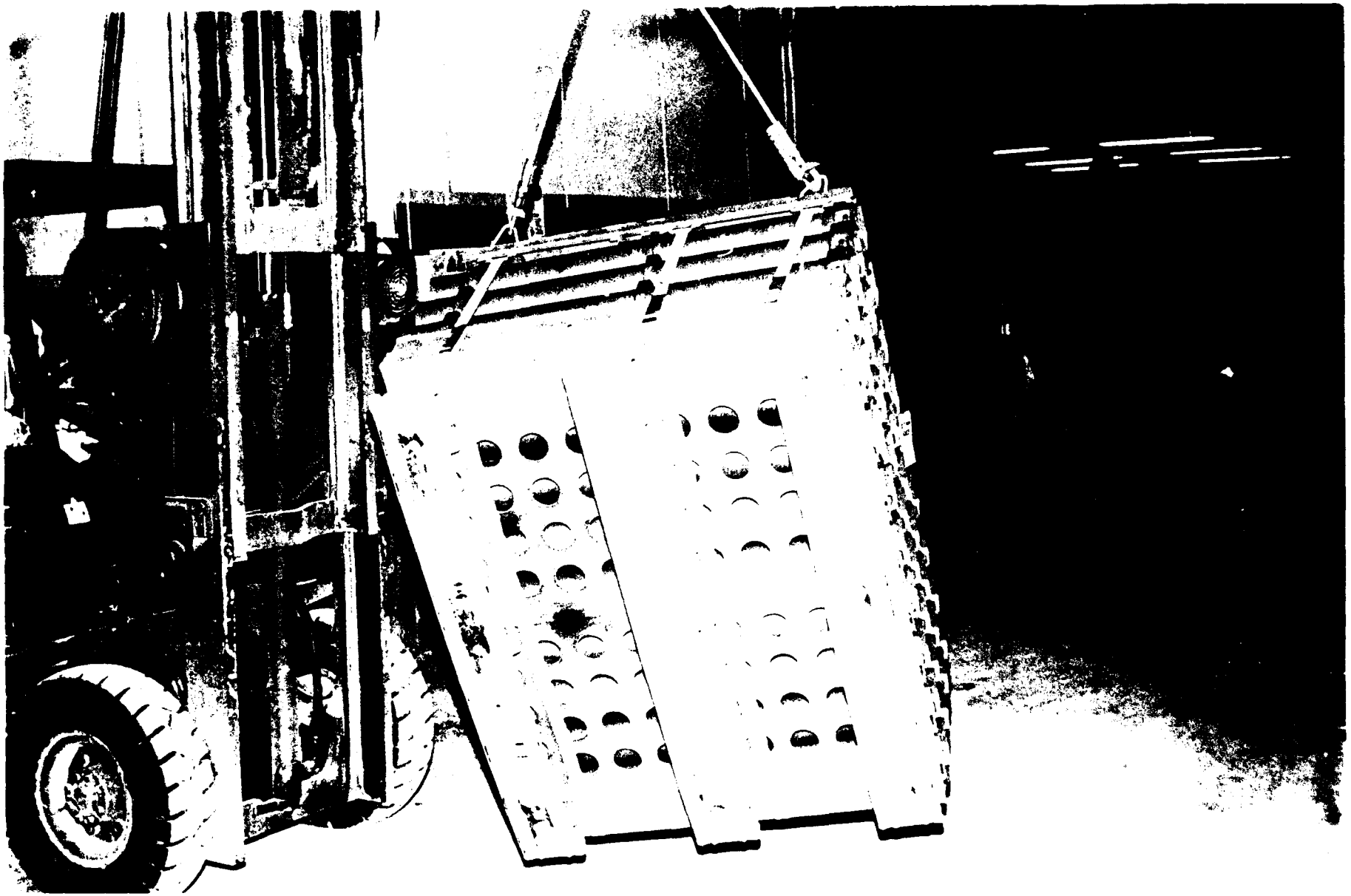

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Photo 9: This photo shows the pallet being top lifted by two adjacent points.

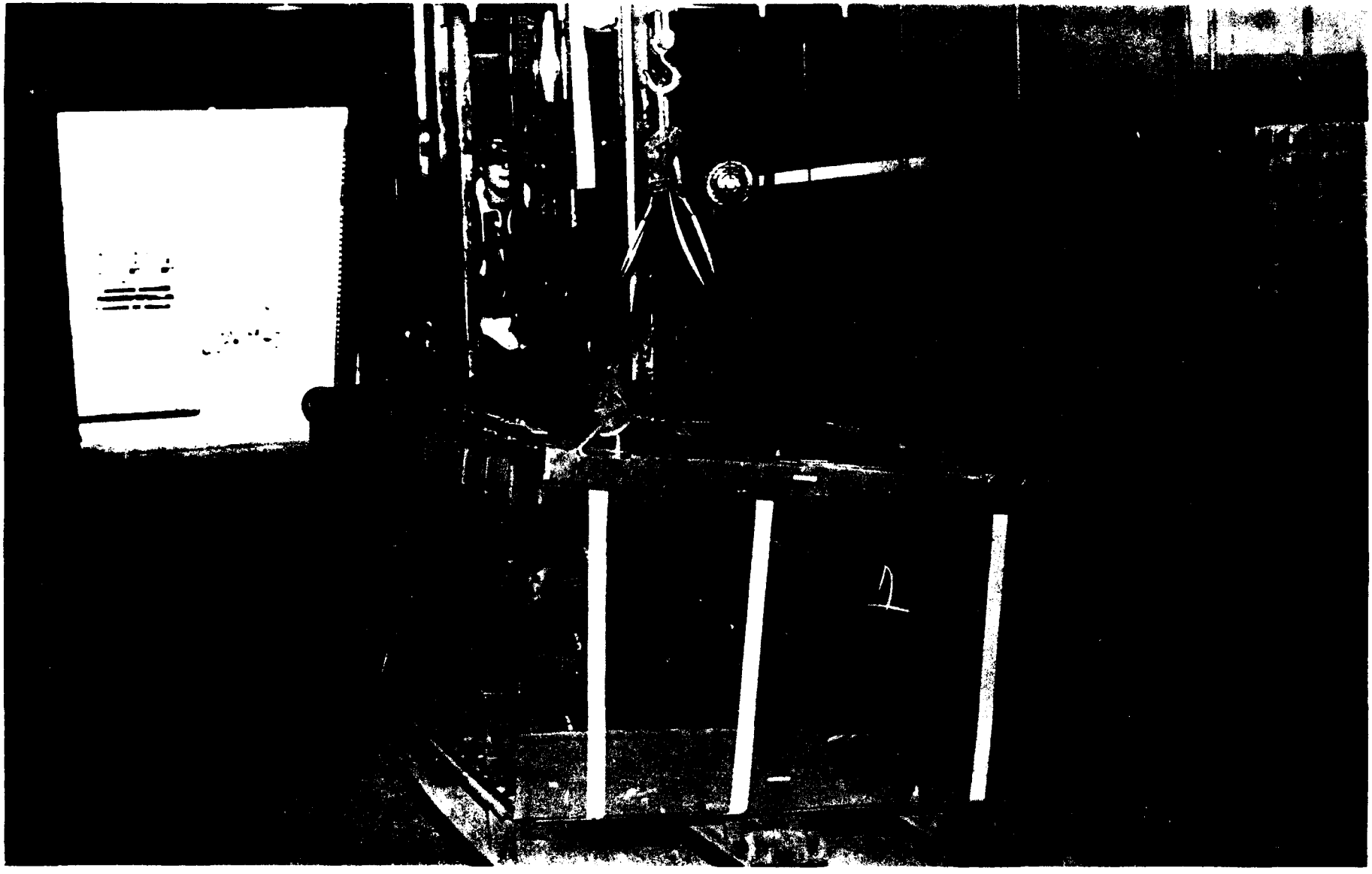

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Photo 10: This photo shows the pallet being top lifted by two opposite points.

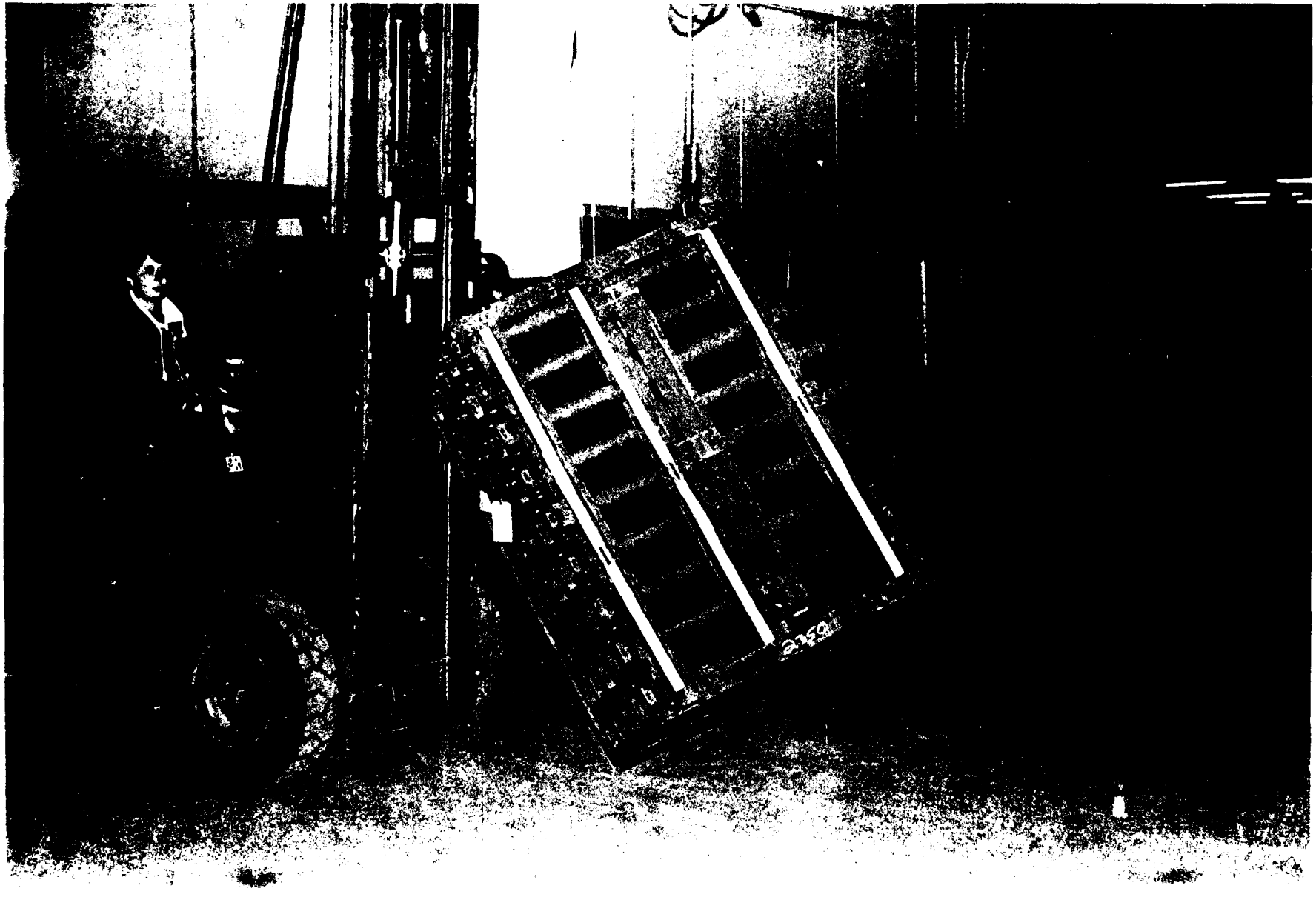

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Photo 11: This photo shows the pallet being top lifted by one point.

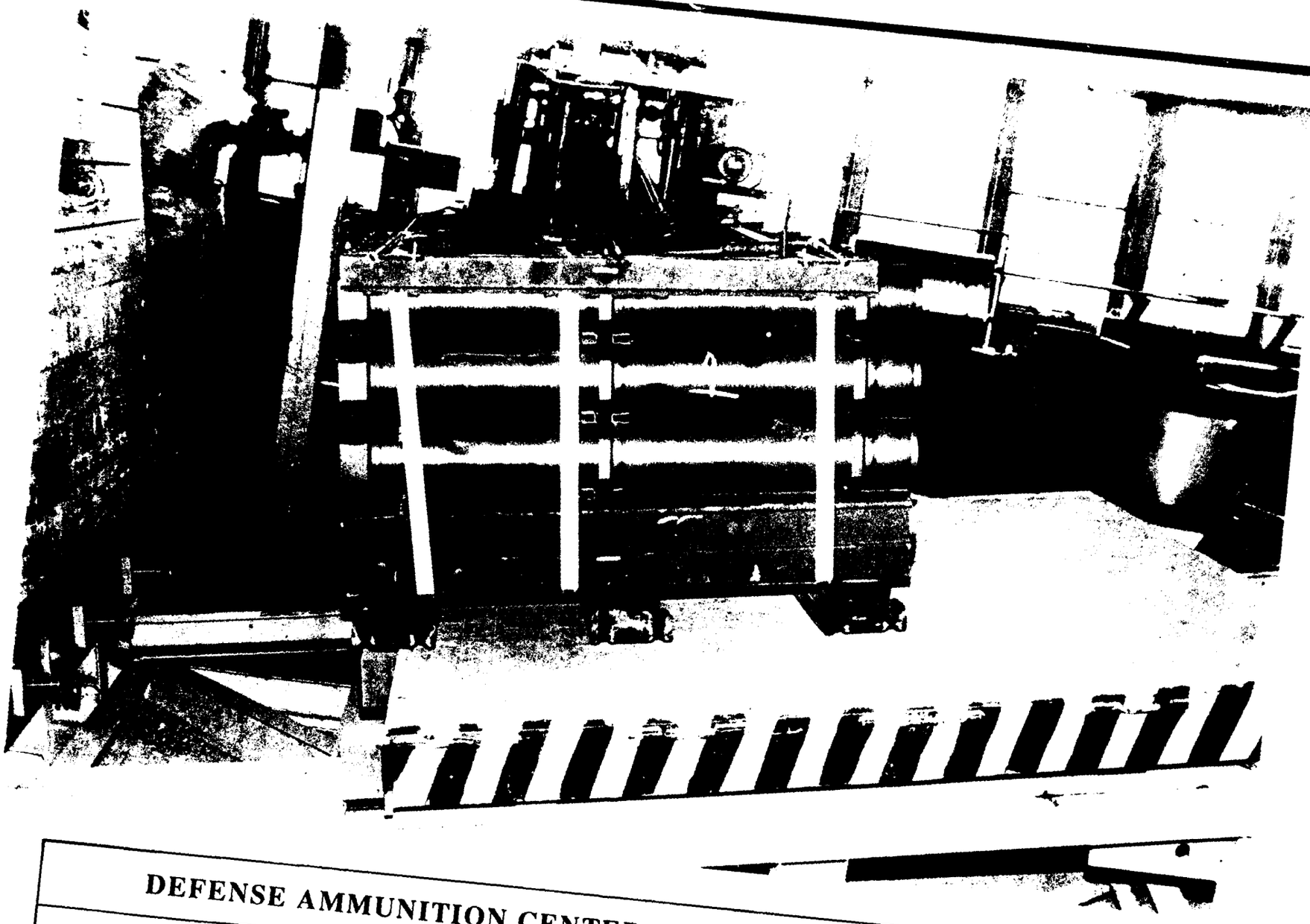

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Photo 12: This photo shows the pallet on the Incline Impact Tester prior to impact one.

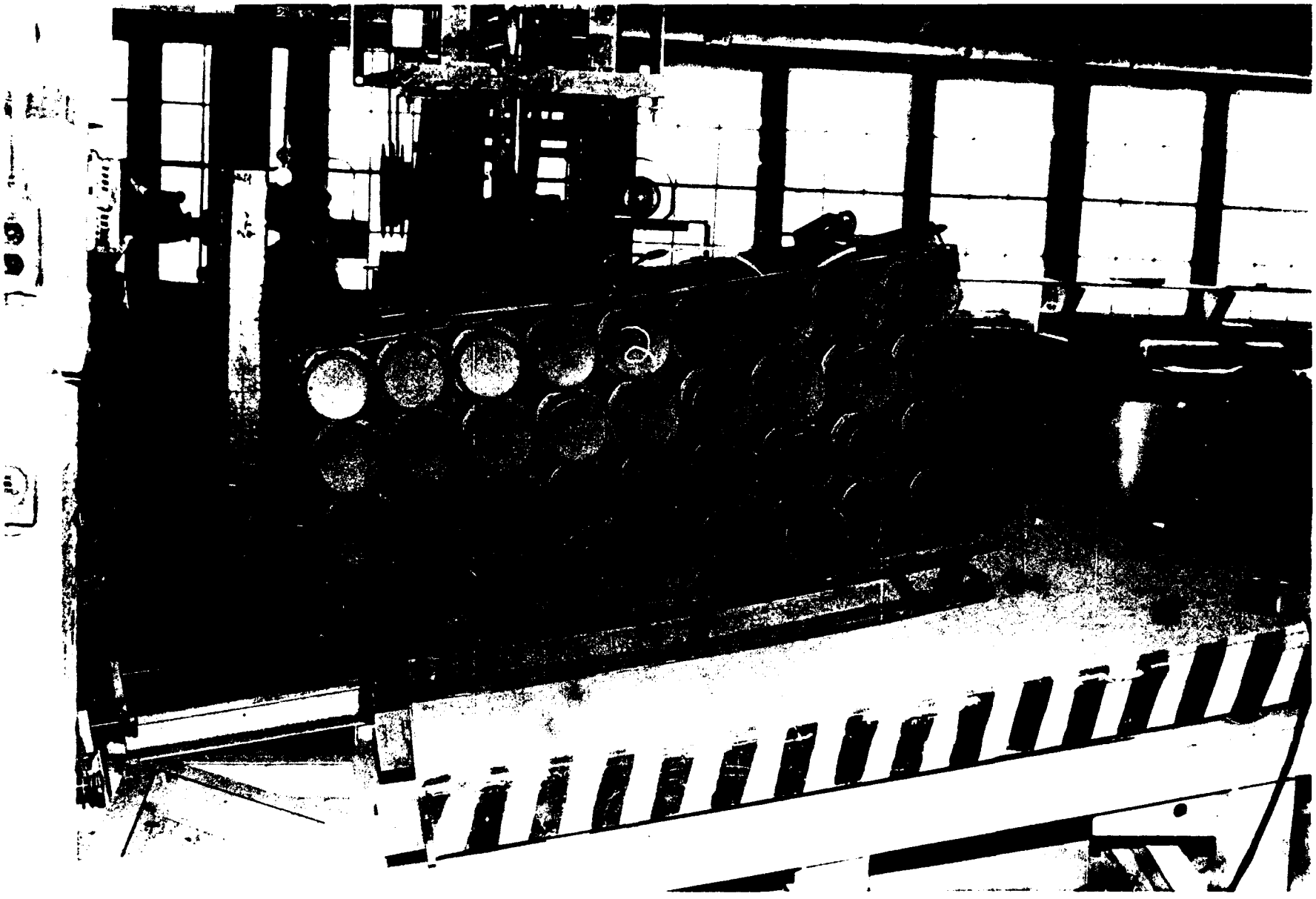

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Photo 13: This photo shows the pallet on the Inclined Impact Tester prior to impact two.

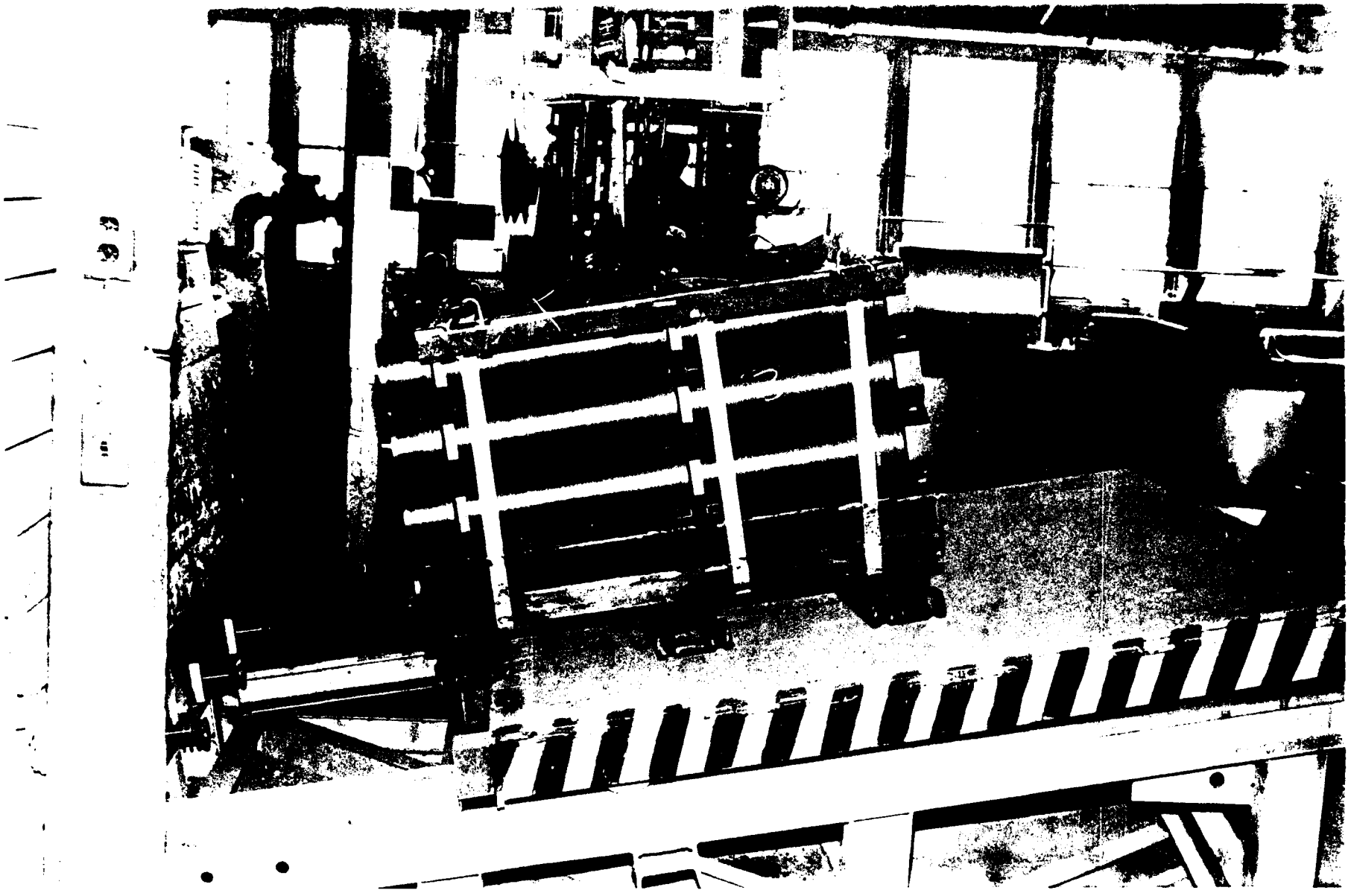

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Photo 14: This photo shows the pallet on the Inclined Impact Tester prior to impact three.

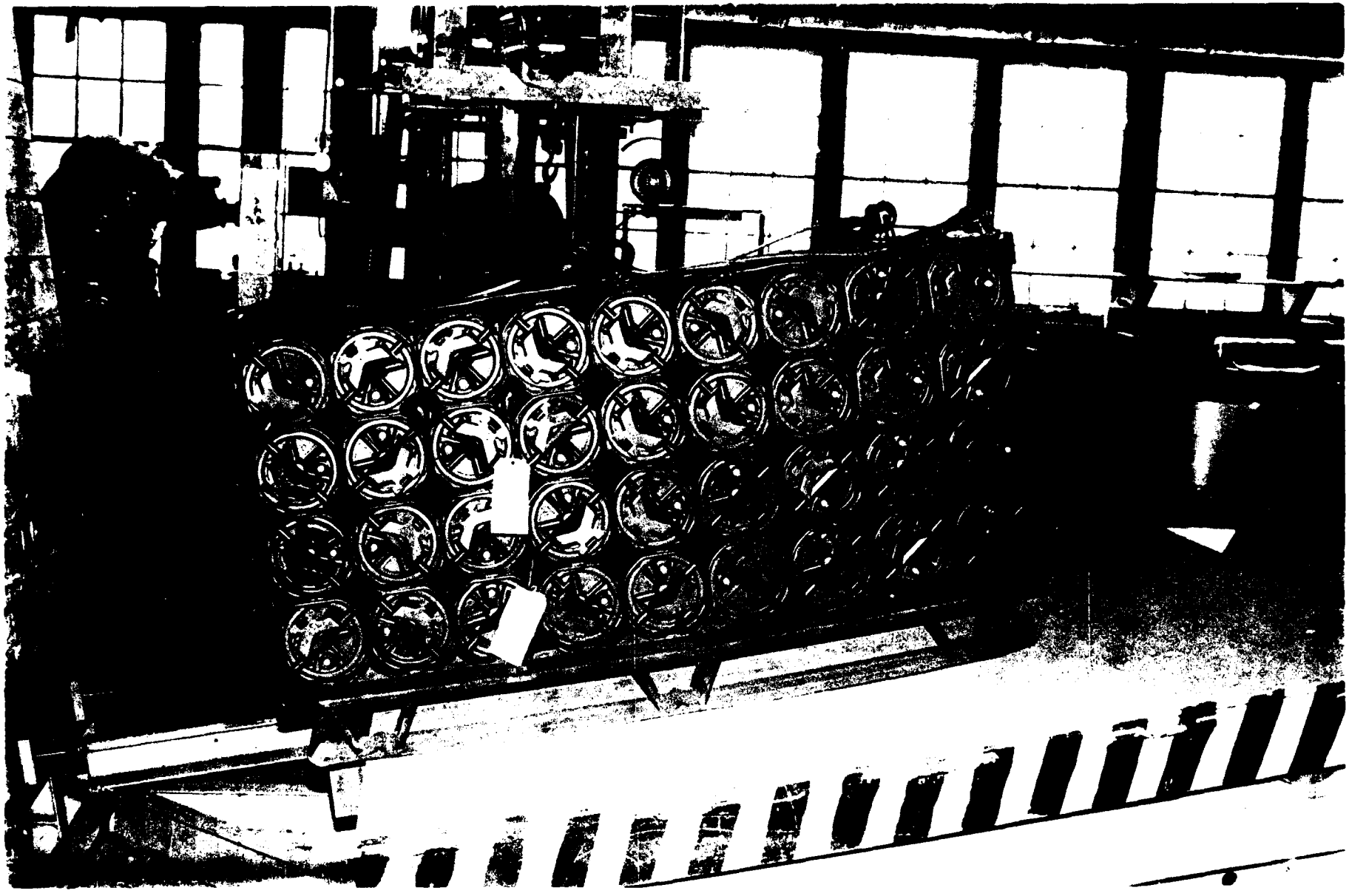

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Photo 15: This photo shows the pallet on the Inclined Impact Tester prior to impact four.

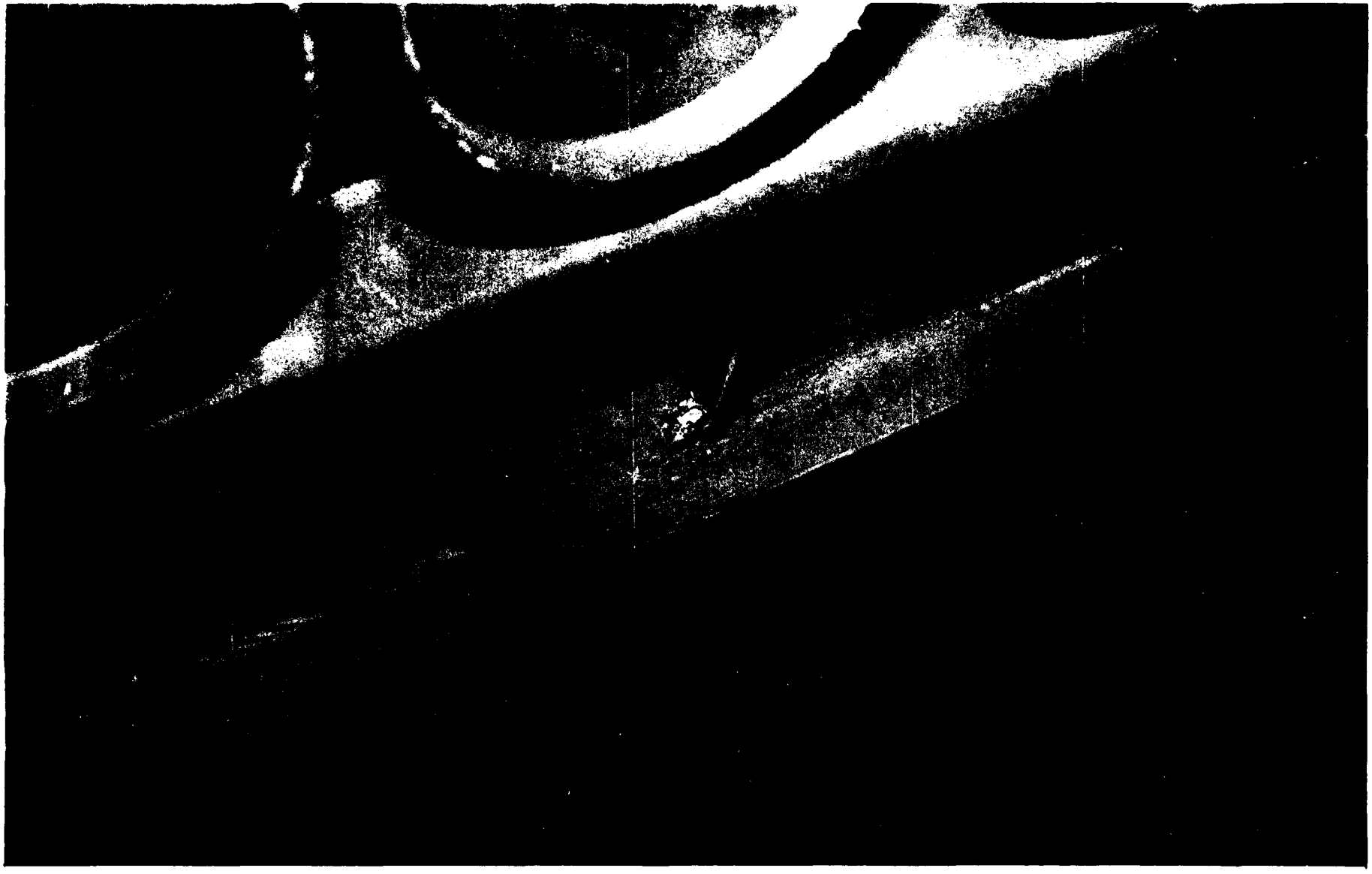

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Photo 16: This photo shows the cracks that formed on the posts during the tests.

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Photo 17: This photo shows additional cracks that formed on the posts during the test.

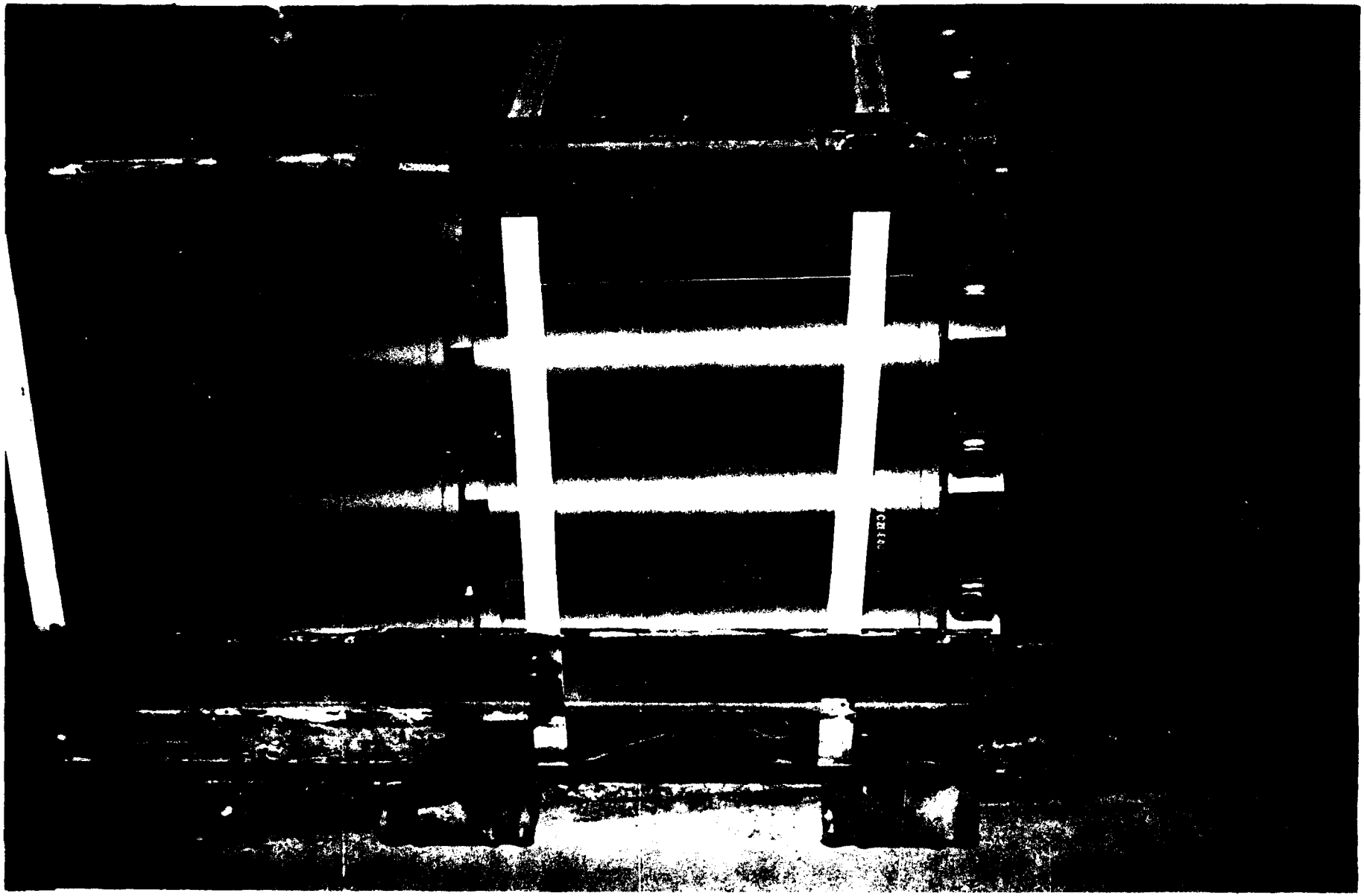

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Photo 18: This photo shows the banding strap that is at an angle with the other straps.

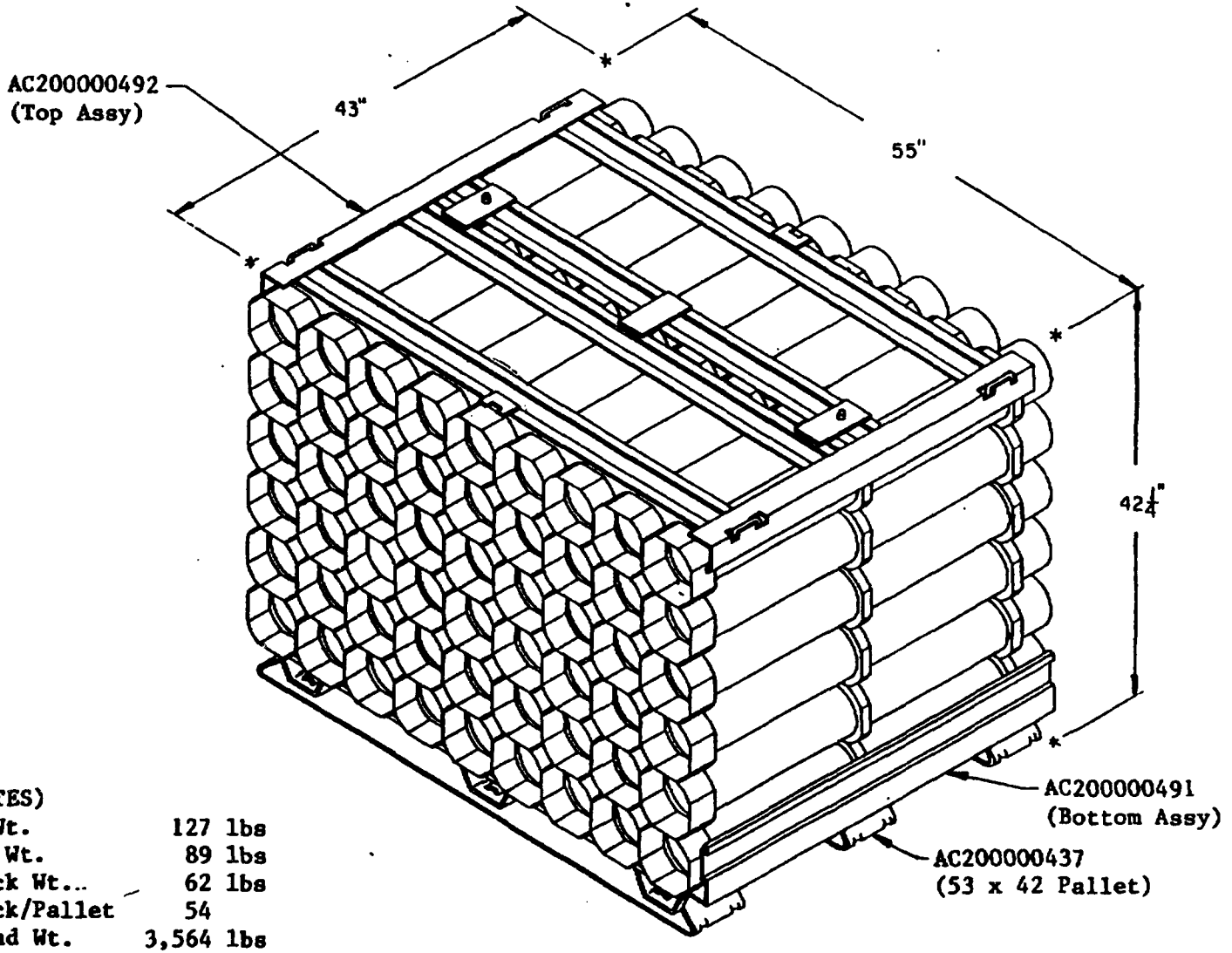
# PART 8

## DRAWINGS

PALLETIZED UNIT LOAD FOR THE

105mm HOWITZER CARTRIDGE IN

THE HORIZONTAL CONFIGURATION




| (ESTIMATES) | |
|---|---|
| Pallet Wt. | 127 lbs |
| Adapter Wt. | 89 lbs |
| Unit Pack Wt... | 62 lbs |
| Unit Pack/Pallet | 54 |
| Unit Load Wt. | 3,564 lbs |

JUNE 1988

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